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Gyrokinetic equations for tokamak turbulence, including a time dependent, background electric field

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We present an extension of existing gyrokinetic Vlasov-Maxwell equations[1] for edge turbulence to include a time-dependent, strong, sheared ExB-flow. The inclusion of a non-stationary strong ExB flow is required if one tries to apply the gyrokinetic formalism to the H-mode transition and ELM bursts. The H-mode transition[2] and ELM bursts[3] are associated with the formation and changes of a strong, radial electric field E_r which varies on a time scale on the order of ~100 μs. Terms, previously neglected, in the gyrokinetic equations associated with the explicit time-dependence of E_r ,must therefore be retained.

A nonlinear, fully electromagnetic set of gyrokinetic Vlasov-Maxwell equations, including a time dependent background electric field, has been derived. In comparison with previous results, the appearance of the polarization drift, and a time dependent volume element, are the main implications of having an explicit time dependent, background electric field. A local energy theorem is also presented. The results are derived in both "flavours" of the gyrokinetic formalism; symplectic and Hamiltonian.

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